THURSDAY, JUNE 9, 1887.

THE ZOOLOGICAL RESULTS OF THE "CHALLENGER" EXPEDITION.

Report on the Scientific Results of the Voyage of H.M.S. "Challenger" during the Years 1873-76 *under the Command of Capt. George S. Nares, R.N., F.R.S., and of the late Capt. Frank Tourle Thomson, R.N.* Prepared under the Superintendence of the late Sir C. Wyville Thomson, Knt., F.R.S., &c., and now of John Murray, one of the Naturalists of the Expedition. Zoology—Vol. XVIII. Parts 1 and 2, with a Volume of Plates. (Published by Order of Her Majesty's Government, 1887.)

VOLUME XVIII. of the Zoological Reports of the *Challenger* Voyage well merits to be called enormous, as it contains no less than 1800 pages. It contains but a single memoir, "On the Radiolaria," by Prof. Ernst Haeckel, of Jena, and is accompanied with a volume of 140 plates.

A great work like this demands more than a passing notice, for even in this age of scientific labour one stands amazed at the physical energy, not to refer to the scientific knowledge, that could have accomplished such a result. Ten whole years of the author's life were devoted to this monograph, which will ever be a worthy monument of a most enduring kind.

Some fifty years ago Meyen, and shortly after Ehrenberg, first described some forms of Radiolaria. Meyen has the merit of having observed and noted the first of these curious forms in a living state, but to Prof. Huxley we are indebted for the first accurate observations on some kindred forms met with by him during the voyage of the *Rattlesnake* in the tropical seas. Ehrenberg no doubt was the first to call attention to the exceedingly great numbers of forms that were to be found in the group, but although he was not ignorant of the researches of his colleague, Johannes Müller, whose memoirs were published in the same Academy's Transactions as his own, he never seems to have paid the slightest attention to them, nor does he even allude to the name given to the group by Müller, that of Radiolaria, by which they are now known.

Just twenty-five years ago Haeckel published his well-known "Monograph of the Radiolaria," which with its splendid atlas of plates, was, and is still, an indispensable work for the student. In this all the species known either by figures or descriptions were reviewed, and arranged in 15 families and 113 genera, of which latter 46 were new; the number of forms observed alive amounted to 144, most of which are figured, in a manner that has not, we think, been equalled, certainly not surpassed.

In 1862, Zittel described the first fossil Radiolaria from the chalk; in 1876, John Murray established the family Challengerida; and above all, in 1879, Richard Hertwig showed the essential differences in the formation called the "central capsule," and in accordance therewith divided the Radiolaria into six orders. From this on, with the exception of the various important works on the fossil forms by Emil Stohr, Dante Pantanelli, Butschli, Dunikowski, and D. Rust, the whole record has been filled in by Haeckel, and it has been almost exclusively based on the collections of the *Challenger*.

These Radiolaria, or Capsulate Rhizopoda, form a peculiar class of the Rhizopoda—Haeckel's "Protista." This class is exclusively marine, and, while possessing many of the features of the Rhizopods, differs from them in the possession of a peculiar "membrane" dividing the cell-body into two distinct parts—the "central capsule" or the internal part with the nucleus, and the external part or "extra-capsulum" with the calymma; the protoplasm of both parts communicates through fine pores, which pierce the capsular membrane. The central capsule is composed of three essential parts, viz. the central nucleus, the intra-capsular sarcode, and the capsule membrane. Besides these elements, the central capsule contains very commonly an internal skeleton, fat and pigment granules, crystals, and vacuoli. The outer part of the Radiolarian body is also constantly composed of the calymma, or a thick extra-capsular "jelly-veil." The matrix or maternal tissue of the external protoplasm and the pseudopodia again very commonly contains fat and pigment granules, the skeleton and vacuoli, and, in addition, "xanthellæ" or "zooxanthellæ," peculiar yellow cells which contain starch, and are unicellular yellow Algæ living as "symbiontes" in true symbiosis with a great number of Radiolaria. The skeleton may be either siliceous or acanthinic, and is sometimes wanting. The four sub-classes, as described in this Report, contain 20 orders; and these, 85 families, which include 739 genera, with 4318 species, of which latter 3508 are described as new.

Radiolaria occur in all the seas of the world, in all climatic zones, and at all depths. Probably under normal conditions they always float freely in the water, whether their usual position be at the surface or at a certain depth or near to the very bottom of the sea. Hitherto, no observation has been recorded which justifies the assumption that Radiolaria live anywhere upon the bottom of the sea, either attached or creeping. However able they may be to creep when they fall on a solid basis, they seem normally always to float freely in the water, with pseudopodia radiating in all directions.

As regards their local distribution and its boundaries, the Radiolaria show in general the same relations as other pelagic animals. Since they are only to a very slight extent, if at all, capable of active horizontal locomotion, the dispersion of the different species from their points of development is dependent upon oceanic currents, the play of winds and waves, &c. These passive migrations are here, however, as always, of the greatest significance, and bring about the wide distribution of individual species in a far higher degree than any active wanderings could do. Anyone who has ever followed a stream of pelagic animals for hours, and seen how millions of creatures closely packed together are in a short time carried along for miles by such a current, will be in no danger of under-estimating the enormous importance of marine currents in the passive migration of a marine fauna. The number of cosmopolitan species which live in the Pacific, Atlantic, and Indian Oceans is relatively large. In each of three great ocean basins, too, many species show a wide distribution. On the other hand, there are very many species which are known only from one locality, and probably many small local faunas exist, characterised by the special development of particular groups. From the very richness of the material, Prof. Haeckel has found it impossible to work out completely the local distribution of all the species.

From the tropics the abundance of species seems to diminish regularly towards the Poles, and more rapidly in the northern than in the southern hemisphere; the latter also appears to possess more species than the former: a limit to Radiolarian life towards the Poles has not yet been found. The greater abundance of Radiolaria in the tropical seas is to be accounted for by the more favourable conditions of existence, rather than by any difference in temperature. One station (271) of the *Challenger* Expedition, situated almost on the Equator, in the Mid-Pacific, exceeds all other parts of the world hitherto known in respect of its wealth of these forms; and more than 100 new species are described from it. The fauna of the Pacific Ocean exceeds that of both the Indian and Atlantic, but the fauna of the Indian Ocean is that least known.

In reference to the bathymetrical distribution, it seems certain that numerous species of this class are found at the most various depths of the sea, and that certain species are limited to particular vertical zones, and are adapted to the conditions which obtain there. In this respect three different Radiolarian faunas may be distinguished—the "pelagic," "zonarial," and "abyssal." More than half of all the species known as recent belong to the last fauna.

The chapter on the geological distribution is full of interest. Radiolaria are found fossil in all the more important groups of the sedimentary rocks of the earth's crust. Whilst a few years ago their well-preserved siliceous skeletons were only known in considerable quantity from Tertiary marls, very many are now known to occur in Mesozoic, and a few in Palæozoic, strata. By the aid of improved modern methods of research, it has been shown that many hard siliceous minerals, especially cryptocrystalline quartz, contain numerous well-preserved Radiolaria, and sometimes these are composed almost entirely of closely compacted masses of such siliceous shells. The Jurassic quartzes (Switzerland), as well as the Tertiary marls (Barbados) and clays (Nicobar Islands), may be regarded as "fossil Radiolarian ooze"; and, since specimens have also recently been found both in Silurian and Cambrian strata, it may be inferred that Radiolaria are to be found in all fossiliferous sedimentary deposits, from the oldest to those of the present day. Among the Miocene Radiolaria, numerous species are not to be distinguished from the corresponding still living forms. On the other hand, those genera which are rich both in species and individuals (recent as well as fossil) present continuous series of forms which lead gradually and uninterruptedly from old Tertiary species to others still living, which are specifically indistinguishable from them

As Chapter XI. of the introductory portion of the Report, Prof. Haeckel gives a very valuable account of the progress of our knowledge of the Radiolaria from 1862 to 1885. In his earlier monograph he had already given a critical discussion of the works which had appeared prior to 1862: we find here a full list of the publications from 1834 to 1884, in which list a little of the author's old trenchant style of criticism breaks out; for he has heaped together in an appendix, to which he gives a somewhat needlessly offensive name, "all the absolutely worthless literature, which contains either only long-known facts or false statements, and which may therefore be entirely neglected with advantage." While we would not, for all the Radiolaria in the sea, give the list of this "foul" literature, we may relieve the reader's mind by at once mentioning that the name of Ehrenberg does not appear in it, and that the value of the laborious works of the great but too self-reliant German in this field meets with all proper appreciation.

The unicellular nature of the Radiolaria was first established by Richard Hertwig in 1879, and was brought by him into conformity with our present histiological knowledge and the new reform of the cell-theory. Huxley, who was the first to examine living Radiolaria with any accuracy, declared, so long ago as 1851, that *Thalassicolla nucleata* was a unicellular Protozoon. Later, both Johannes Müller (1858) and Haeckel (1862), recognising the peculiar "yellow cells" which occur in many Radiolaria, in large numbers, as true nucleated cells, thought it impossible to maintain this view; and it was not until Cienkowski (1871) and Brandt (1881) had shown that these "yellow cells" did not form part of the Radiolarian structures, but are symbiotic unicellular Algæ, that it was possible to revive and demonstrate anew the unicellular nature of the Radiolaria.

From a morphological stand-point the individuality of the unicellular elementary organism is obvious in the solitary Radiolaria (Monobia); and the whole body with all its constituent parts, and not merely the central capsule, is to be looked on as a cell. But this unicellular organisation must be noted as differing from that of all other Protista, inasmuch as an internal membrane (capsule membrane) separates a central from a peripheral portion.

The membrane of the central capsule is invariably present at one period or another of the life of the organism. Karl Brandt, indeed, has recently stated that in some forms it is absent; but Haeckel has recognised its presence in over one thousand species, and even in some of those in which Brandt was unable to find it. It is often very delicate and may easily be overlooked, though the application of the proper reagents will render it always discernible. Those Radiolaria in which for a time it is absent are young of species in which the membrane is only formed immediately before sporification, and persists but for a short time.

All Radiolaria possess a nucleus, but they present two different conditions in respect of its behaviour, since in their young stages they are uninuclear, and in later stages they are multinuclear. Before the formation of swarm-spores the nucleus divides into many nucleoli. Thus the nucleus is pre-eminently the organ of reproduction and inheritance. The division of the originally single nucleus into many small nuclei may take place at very different periods, so that Haeckel divides the Radiolaria into the "precocious" and the "serotinous." Into the subject of the skeleton formation and that of phylogeny the space at our command will not allow us to enter; it will suffice to say that they are treated at great length and with consummate skill.

In such an onerous task as that of describing this mass of varied forms, one always, as the author observes, "runs the risk of either doing too much or too little in the way of creating species"; but he contents himself with the reflection that in the light of the theory of descent this danger is of little consequence.

In the carrying out of the troublesome duty of making the many thousands of required measurements, the author gratefully thanks his friend Dr. Reinhold Teuscher, of Jena, for the patient and careful manner in which he performed this part of the work. The figures of new species, about 1600 in number, which appear in the atlas accompanying the Report, were nearly all drawn with the camera, partly by Mr. A. Giltsch and partly by Prof. Haeckel; but the former has drawn all the figures on the stone in a very masterly way, so that the illustrations present a splendid series of beautiful forms, like the stars in the firmament for number, and surpassing these in the wonderful diversity and complexity of their outlines.

It was indeed a fortunate circumstance that so distinguished a naturalist, with such an intimate knowledge of the Radiolaria, should have been willing to undertake such a task, and exceedingly fortunate for science that he should have been enabled thus to finish it.

A GERMAN TREATISE ON THE VEGETABLE KINGDOM.

Die natürlichen Pflanzenfamilien. Von A. Engler und K. Prantl. (Leipzig: Engelmann, 1887, &c., being issued in numbers at irregular intervals.)

WITH the first three numbers of the above-named work, which are now before us, Profs. Engler and Prantl have embarked on an enterprise of some magnitude. The editors, having recognized the want of a comprehensive treatise, in German, on the Vegetable Kingdom, which should at once be scientifically sound, and yet be written in a style suitable for the use of those who are not professed botanists, have determined to meet that want. With this object they have enlisted the assistance of a number of collaborators: anyone who is conversant with the literature of Botany produced in Germany in recent years will see, on reading the list of names, that Dr. Engler has secured the co-operation of a very powerful staff, including many of the most prominent representatives of the science in that country.

With their aid the editors propose to produce a work, extending to some 5000 pages octavo: the whole is to be divided into five parts, one of which will be devoted to the Cryptogams, under the editorship of Prof. Prantl; one will treat of the Gymnosperms and Monocotyledons, and the remaining three of the Dicotyledons, under the editorship of Prof. Engler. The production of the several parts will proceed simultaneously, and they will appear in numbers, at intervals during the next five or six years: thus the distribution of the cost (which in itself is not excessive, considering the quality and extent of the work) over a lengthened period, will bring the book within the reach of a wide constituency.

The first three numbers will give some idea of what will be the scope and character of the work as a whole. One of these is the first instalment of the *Palmæ*, by Dr. Drude. It opens with twenty-six pages of text, illustrated by numerous carefully chosen and excellent woodcuts, on the morphology and anatomy of the vegetative organs, the inflorescence, fruit, and seed of the plants of this order; then follow notes on the distribution, affinities, and uses of the family, and finally its classification. A detailed description of the genera succeeds this general treatment, and it is illustrated by numerous good figures representing the habit of the plants, and dissections of their flowers: this will, in fact, be somewhat like an illustrated and abbreviated "Genera Plantarum," written in German, and in a semi-popular though sound style.

The second number issued contains the *Juncaceæ*, by F. Buchenau, and the *Stemonaceæ* and *Liliaceæ* by Dr. Engler. The subject-matter is treated in the same spirit as the above, and it may be assumed that this method will be pursued throughout the whole work.

But a more special interest attaches to the number which was third in its order of issue; and that on two distinct grounds: first, because from it we gain a more general idea of the plan and scope of the work, and secondly because it is chiefly the work, and probably the last work, of the late Prof. Eichler, a botanist whose loss will be very widely felt (see NATURE, vol. xxxv. p. 493).

The first pages of this number, written by Dr. Engler, give in brief the general plan of the whole work; the main lines of classification being those in common use, though some of the terms used have not as yet been generally accepted. They are as follow:—

I. Mycetozoa.
II. Thallophyta:
  (*a*) Schizophyta.
  (*b*) Algæ.
  (*c*) Fungi.
III. Embryophyta zoidiogama (= Archegoniatæ):
  (*a*) Bryophyta.
  (*b*) Pteridophyta.
IV. Embryophyta siphonogama (= Phanerogamæ):
  (*a*) Gymnospermæ (= Archispermæ).
  (*b*) Angiospermæ (= Metaspermæ).

Then follows the general treatment of the Gymnospermæ, of which four classes are distinguished, the Cycadinæ, Cordaitinæ, Coniferinæ, and Gnetales. It is worthy of note that here the fossil forms are taken into account, and Cordaitinæ, as well as fossil forms of the Cycadaceæ and Coniferæ, are described in their proper places. It will be unnecessary after what has already been said to follow the mode of treatment of the Gymnosperms further; suffice it to say that, while due prominence is given to the external morphology and classification, the results of recent investigation on the development of the sporangia and embryo find a place, *e.g.* those of Treub and Warming on the Cycads, and of Strasburger and others on the Coniferæ. A peculiar interest will attach to the pages on the morphology of the female cone in the Coniferæ, since this will be the last expression of the opinion of Eichler on a subject to which he had devoted special attention.

While extending a welcome to this new enterprise, we may compare it with other undertakings of a somewhat similar nature. Among the comprehensive classificatory works of recent years, the most prominent is